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The Diminishing Jaw of Civilized People

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"Many illustrations have been offered, by those few persons of high authority who still maintain that acquired habits, such as the use or disuse of particular organs in the parents, admit of being hereditarily transmitted in a sufficient degree to notably affect the whole breed after many generations. Among these illustrations much stress has been laid on the diminishing size of the human jaw, in highly civilized peoples. It is urged that their food is better cooked and more toothsome than that of their ancestors, consequently the masticating apparatus of the race has dwindled through disuse. The truth of the evidence on which this argument rests is questionable, because it is not at all certain that non-European races who have more powerful jaws than ourselves use them more than we do. A Chinaman lives, and has lived for centuries, on rice and spoon-meat, or such over-boiled diet as his chopsticks can deal with. Equatorial Africans live to a great extent on bananas, or else on cassava . . . . It follows that the diminishing size of the human jaw in highly civilized people must be ascribed to other causes, such as those, whatever they may be, that reduce the weight of the whole skeleton in delicately nurtured animals."

The above paragraph is quoted from *Hereditary Genius*, Prefatory chapter, by Sir Francis Galton, 1892. Galton stood against inheritance of acquired traits even before the birth of modern genetics. Subsequent experiments dispelling the use-and-disuse theory have proved that acquired traits and abilities are not transmitted from parents to their descendants. With respect to this particular point, few biologists today disagree with Sir Francis. The purpose of quoting Galton, however, is not to reopen the obsolete issue of acquired inheritance but to discuss the attitude of scientists of that day, both pro and con, towards the "facts" upon which their whole argument centered. An examination of several facets involved in the simply stated story of the diminishing jaw may provide us with historical perspective and help us to see ourselves clearly and evaluate some of our current scientific thought objectively.

At the outset we notice that the argument cited was not between laymen but between learned persons of high authority. From the context it is clear that both parties—those who maintained that acquired habits are hereditary and Sir Francis who maintained that "bad nutrition of parents . . . has no effect on the natural faculties of the child"—agree that the jaw of the "highly civilized" Europeans was diminishing in size. They differed only in the interpretation of the fact which, in turn, depended upon the comprehensiveness of the scientist's knowledge on the subject under consideration. Galton disagreed that soft diet was the cause for man's diminished jaw. His extensive knowledge about the diet of other peoples

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led him to cast serious doubt upon the use-and-disuse theory. [The "facts" cited by Galton are open to question. Approximately one-third of the Chinese population has never been on a rice diet. Chopsticks are used because the sight of a knife on the dining table is not considered "highly civilized" and food that needs to be cut is cut in the kitchen. The unleavened baked corn-pone that is staple food in North China is the hardest kind of food I know of. These points are, however, irrelevant to the aspect of the problem I shall discuss.]

Unanimous acceptance of the diminishing jaw theory indicated that prominent biologists of that day were more interested in the interpretation of an assumed fact than questioning, studying, or establishing the fact itself. The size of the human jaw indeed varies from race to race as well as from individual to individual and, in all probability, is partially controlled by genetic factors, much like other morphological and anthropological characteristics. To my knowledge, no one has been able to correlate the European jaw size with either European civilization or with European food. There is too much variation within the Europeans and within Africans and Asians. Well, then, what kind of convincing evidence did the scientists in the nineteenth century possess that led them to unanimous belief in the diminishing jaw? Did they have any evidence at all? Did they need any?

The decade of the 1890's is not long past. Natural sciences made great advances in that period. Many discoveries and ideas in nuclear physics were initiated in the last few years of the nineteenth century. To mention a few: Röntgen (1895) discovered that penetrating X-rays originated in a vacuum tube and took X-ray photographs of human hands. Becquerel (1896) discovered radiation from the uranium salt, potassium uranyl sulfate. Wilson (1894–96) found the principles involved in the cloud chamber, in which the ions formed in the air by radiation acted as condensation centers of the cloud. The Curies (1898) discovered the new element radium whose radiation is several hundred times as great as that of uranium and coined the general term radioactivity. Clearly, scientific experimentation and interpretation were not lacking at that time. Why, then, when scientists discussed a problem in man, should they lose their scientific rigorousness and accept hearsay? To gain some understanding of this attitude, we must look at the social, economic, and political conditions in which these scientists found themselves and by which human thought is inevitably influenced.

Much has been said about the scientists' responsibilities to and influences on society. Conversely, we may also examine the influence of social factors on the attitude and thinking of scientists. During the 1890's Europe was so much superior in military and economic strength to the rest of the world that it was taken for granted beyond any doubt that her people were also biologically superior and evolutionally more advanced. This needed no separate proof; existing conditions were proof. Therefore, the European jaw must be diminishing ("on theoretical grounds"). Not only that; since high intelligence constitutes a biological basis for superiority, it is to be found only among Europeans. Thus, Sir Francis Galton wrote (*op. cit.*): "The natural ability of which this book mainly

treats, is such as a modern European possesses in a much greater average share than men of the lower races." Similar statements may be found in other writings, but one example from an outstanding scientist must suffice. When we see some of these deep rooted social beliefs prevailing in that period, we no longer wonder why certain hypotheses were accepted as facts without proof. The line of reasoning may be summarized as follows: Europeans—high intelligence—delicately nurtured—diminishing jaw; Lower races—low intelligence—crudely nurtured—powerful jaw. The deductive structure is attractive; but no trace of scientific evidence has yet been found to substantiate it. [If "much stress had been laid" on the growth of the body-hair in man instead of on the size of the jaw, one wonders what ingenious interpretation would have been produced by the nineteenth century scientists. This, however, also is beyond the scope of the present discussion.]

I believe that the scientists of the 1890's were sincere in their assertion of the diminishing jaw of "highly civilized people". To them, it was fact, no matter how unconvincing it sounds today. Truth, particularly in a young and growing science is only relative to time. It is natural to find varying social and scientific beliefs at different periods in history and at varying stages in the development of human thought. That the story of the diminishing jaw fails to convince us in 1960 does not lessen to the slightest extent the status of Galton as one of the great scientific thinkers of the nineteenth century. Galton himself was well aware of the time element in scientific truths. He said: "The earlier part of the book should be read in the light of the imperfect knowledge of the time when it was written, since what was true in the above respects for the year 1869 does not continue to be true for 1892". From 1869 to 1892 was merely a period of twenty-three years. If he were to revise his book today, I am sure he would say: "What was true for 1892 does not continue to be true for 1960." The lesson to be derived from this is that what seems to be true for us today does not necessarily continue to be true for, say, 1983; that is, twenty-three years hence. Therefore, I am not primarily concerned in this discussion with the truth or falsity of any particular belief or assertion. Let history decide that. Rather, aware that one's beliefs and attitudes are largely a product of the circumstances in which one finds himself, I shall try to detach myself from the present in the hope of being able to see a little more of the changing attitude of man at different times.

Galton regarded nineteenth century Europe "highly civilized". Measured by the 1960 standard, it perhaps would be regarded otherwise. One cannot fail to notice that the adjective "highly civilized" referred to the state of affairs as viewed by the writer at the date of writing. By the same token, how will we of 1960 be measured centuries later? Thus, the state of being "highly civilized" has no absolute meaning; it is synonymous with "the present condition". When we think of early man, with weapons to hunt, with fire to cook, furs to keep him warm, and a cave for comfortable living, we would doubt very much if he had ever regarded himself as anything less than being highly civilized. It is not impossible that he had wondered about the possible future "deterioration" of the

human race, because he, too, might have remembered the more powerful jaws (real or imaginary) of his ancestors.

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In attempting to extrapolate from the present to the future, we should constantly remind ourselves that if the remote past is only vaguely known to us and difficult to study, the remote future is even more so. Some present day philosopher-biologists consistently preach the doctrine that human genetic constitution has been weakened by the advent of "modern civilization" and is in process of continual deterioration. If true, the modern man, the highly civilized, must be regarded as the result of previous deterioration, a process going on since the emergence of man, because man has never ceased to improve his living conditions.

When definitions are ignored, we are likely to run into semantic difficulty. If we call the change from the early man to modern man "progress", then the continual change in the future is a continuation of the same progress. If we label the change from the early man to modern man "deterioration", then the continual change in the future is a continuation of the same deterioration. It matters little which term we adopt, but once adopted, we should use it consistently. The fact is that we continue to "progress" or "deteriorate" (whichever you prefer) to a higher civilization by definition, deviating more and more from early man and probably also from the nineteenth century man. Whether we should describe future change by a four-letter work (e.g., g o o d) or by a three-letter word (e.g., b a d) is entirely a matter of preference. Some of us apparently would like to reverse the rule in the middle of a game, calling the changes in the past progressive and the possible changes in the future regressive! This being done, the unavoidable conclusion is that the present state is at the peak of the quality of the human genetic stock. Does such a peak exist? Is it likely that we should happen to witness the turning point along the eternal axis of time that has no beginning and has no end? If we must express preference, would it not be more plausible to suppose that the great days of humanity are yet ahead of us than that they are behind us?

The idea that our inherent (genetic) faculties are deteriorating is not new. Galton observed that not only the jaw has been diminishing but also that "a high degree of ability . . . is exceedingly rare now" (i.e. in 1892). Now (1960), we have continued to witness the unsurpassed excellence of British scientific achievements in all fields.

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Heredity is a very conservative force in nature. Apart from incredible precision in self-duplication of the gene, there is in nature a balance of forces that tends to preserve the population as it is. In the event of disturbance, these forces tend to restore in due time the original status of the population. When we consider the genetic changes in a population as a whole, we must specify distinctly the order of magnitude of the time interval in which the genetic change is to take

place. In terms of hundreds and thousands of generations, the change may be appreciable in certain respects (but not necessarily in other respects). However, in a period of a few generations the change would be so infinitesimal that for all practical purposes the genetic content of a population may be taken as constant, remaining at a certain equilibrium state determined by the rules of nature as expressed by the prevailing environmental conditions. Without this high degree of stability of nature, we would literally find a new biological world every Spring, if not wake up to a new world every morning!

We have also heard discussion of the improvement of the human race. Some believe that the improvement might be accomplished through the application of simple Mendelian laws. Among all the advocates from various scientific fields, we note that there is not a single professional plant breeder nor animal breeder. Breeders know well how many problems are created by breeding. Their accomplishments, obtained from many undesirable effects and at the price of severe selection, have been commercialized and made known to the general public, but the problems accompanying the accomplishments remain known only to the breeders themselves. It is no wonder that professional breeders hesitate to suggest the breeding of man, even if the breeding methodology were applicable to man. (As a former plant breeder, I think the method hardly applicable.) There still remains the question of the adequacy of our wisdom and foresight if and when all technical matters are solved.

Time acts as a sieve screening the scientific value and validity of one's findings. A false claim, however attractive or appealing at the time when it is made, will die out in due time, although it may flourish for a short period as demanded by the existing social fashion or political conditions. A true finding, upon further research, continues to develop and grow into a full fledged science. This we can see very clearly from history. Limiting ourselves to the period of the 1890's, we see that the initial findings of the physicists I mentioned earlier, each based on experimental evidence, have developed into the sophisticated science of nuclear physics of today, while the philosophy of the biologists, e.g., that on the diminishing jaw of the civilized people, has rapidly faded from the scientific thought, though it was once accepted as an axiomatic truth.

In the foregoing I have discussed an instance of the effect of social and political influences upon scientific thought and the attitude of the scientists. Certain principles involved are as true today as they were before. Some current assertions and thinking of biologists are of a type not unlike that of the diminishing jaw and are based on no sounder foundations; however, a new topic takes the place of an old one. It is a new bottle containing the same wine. I have cited the belief of the decline of human intelligence and the deterioration of man's genetic endowment as examples. Those assertions were based on intuitive deductions rather than scientific findings. Subsequent studies yielded no support for those theories. On the other hand, we have the very flattering doctrine that man is unique and can control nature. Indeed, man is unique in many respects and is utilizing the forces of nature to his advantage. But we must not overlook the fact that every other species is also unique in certain respects and also combats and utilizes nature

for its own advantage. Man, after all, may not be uniquely unique. The point I am trying to make here is that both views, pessimistic and optimistic, reflect more of the personality of the authors than objective pictures of biological realities.

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In addition to the purely academic subjects mentioned above, genetics has frequently been employed in varying degrees as a scientific basis for the discussion of current public issues ranging from those of medical care and public health to those of international politics and military security. On these various problems, however, competent geneticists hold diametrically opposing points of view. To these are added the more varied viewpoints of physicists, chemists, and other scientists who curiously have acquired a new interest in human genetics. A science that has long been suffering from retardation in growth is suddenly in the last few years in the spotlight. Housewives and candidates for public offices speak of mutations.

The possible dangers from radioactive fallout and the subject of world disarmament have also been discussed inter-relatedly. A number of scientists cite the fallout danger as a strong reason for disarmament. However, when I asked one, a renowned chemist and leader of scientific organizations while he was visiting Pittsburgh—"If the fallout is not dangerous or if its danger can be controlled or eliminated to a comparatively tolerable level, would you still be for disarmament or would you be for continued arms race?" the answer is that he would be for disarmament just the same. (Fortunately so.)

If one hundred pounds of a certain kind of fertilizer are added to a plot of wheat field, the yield is, say, 100 bushels. If no such fertilizer is added, the wheat yield is still 100 bushels. In such a situation we would say that the fertilizer has no effect on yield. Similarly, if the fallout is dangerous, he favors disarmament. If the fallout is not dangerous, he favors disarmament just the same. In such a situation, fallout danger cannot be regarded as a reason for disarmament even if it is actually dangerous. Earlier I have mentioned the phenomenon that when scientists talk about a human problem, they lose their rigorousness of argument and are strongly influenced by current social conditions. Nowhere do we see this as clearly as in this example.

The truth of a statement (i.e. a scientific fact) does not necessarily qualify it to be a valid reason for certain human actions or decisions. Do we drink water because it is H_2O? If water were HO, as originally suggested by Dalton, should we not continue to drink it just the same? There seems no necessary relationship between a fact and its being a reason for something else. On the other hand, a false statement does not necessarily prevent it from being a real reason for certain human actions.

In the foregoing paragraphs I have implicitly assumed that the fallout from radioactive dusts is harmful to man, the word harmful being used in a non-specific sense. I have not discussed the truth or falsity of this assumption because, in the first place, it is irrelevant to the problems I am talking about here, and

secondly, no amount of verbal debate can create any information on this subject. We must await quantitative experimental and observational data. Returning to the subject of world disarmament (not U. S. disarmament), we recall that there have been attempts at disarmament long before the advent of the age of nuclear energy. The familiar 5:5:3 ratio not only was agreed upon on paper but was actually carried out to some extent in practice, even though for a short period of time. The obvious advantages of having world disarmament are many. The arguments for military alertness are also very strong. The main point is that the cause for world disarmament may be well argued irrespective of the truth or falsity of the fallout danger. There is no need for scare talk. The noble human hope of "no more war" is shared by everyone at all times in human history, but it is not based on the source and form of energy with which war is executed. (Indians with bows and arrows had hoped for a dependable and honorable peace treaty even more sincerely than some of us do today.)

The play-up of the fallout danger in recent years cannot be explained on a purely scientific basis, just as the belief in diminishing jaw cannot be justified on the evidence they possessed. This play-up must be partially attributed to social and political factors and partially to our uncertainty as to the extent of the harmfulness of fallout. In 1947, two years after the explosions in Hiroshima and Nagasaki but several years before the onset of stop-the-weapon-tests movement, Professor J. B. S. Haldane in a highly mathematical paper "The dysgenic effect of induced recessive mutations" (*Annals of Eugenics 14:* p. 42) considered the hypothetical million survivors of an atom bomb explosion who have received a mean dose of gamma radiation of 20 roentgens and came to the following conclusions:

> "Human genes cannot be much more sensitive to radiation than those of *Drosophila*, otherwise the rate of spontaneous mutation in man would probably be higher than is the case . . . 4000 mutations would involve 2000 deaths in all, spread over very many generations and occurring at a rate of the order of two per generation. . . . It might be ten times as great. But even this would only give about twenty deaths per generation; and many of these might be in early embryonic life, and therefore negligible either from a humanitarian point of view or from the point of view of mere population size. . . . The effect of dominant and semi-dominant mutations will certainly be more spectacular, as these will all appear and mostly be eliminated in a few generations. It should, however, be remembered that many dominants and semi-dominants are due to structural changes, and that these increase approximately with the square of the dose, and are not likely to be very numerous with doses below 100 r."

It should be noted that Professor Haldane was considering the survivors of a nuclear explosion who received a high dose of radiation (20 r) in one shot, not the low fallout radiation which amounts to approximately 0.10 r in a period of thirty years. Since the onset of the stop-the-weapon-tests movement, the atmosphere and the tone of the estimation of the fallout danger have abruptly changed. How may we account for this change in attitude on a purely scientific basis, ignoring the political viewpoints of the scientists involved? During the height of the stop-the-tests movement some scientists have expressed themselves by writing letters to federal government officials concerning the fallout danger,

presumably on the basis of their scientific knowledge. The effectiveness of the appeal of these scientists was, however, seriously undermined by the total silence of the Soviet scientists on the subject. They did not write a similar letter or make similar estimates, and it is doubtful whether they hold the same view about the fallout danger. Why the abundance of the danger talk in one country and the total lack of it in another? Is this not sufficient to show that it may not be wholly of a scientific nature? Apparently the mixture of science and politics has not yet been put into a high speed centrifuge.

The political factor alone can, however, account for the attitude of only a limited number of scientists. The majority's susceptibility to the danger talk, I think, is at least partially due to some form of the diminishing jaw complex. Some of us today worry about the deterioration of the "modern man" no less than Galton did three quarters of a century ago. The possible fallout danger fulfills the need to make the deterioration concept a little more substantial. If we did not have the problem of fallout, we would have something else to fulfill the need and there are many ready substitutes.

The prudent judgement that overestimates the biological effect of very low doses of radiation is certainly wise and agreeable. No one should underestimate the possible radiation hazard to man, however small. We also accept the fact that nuclear energy is here to stay and must be utilized to our best advantage. This energy is not to be feared through ignorance, but to be respected through knowledge and understanding.

What has been said about the issue of the diminishing jaw applies equally to the issue of fallout danger. One point may be repeated here: time will determine the validity of unproved scientific assertions. Health physics has already become a science of its own. Twenty-three years later, in 1983, results of experimental studies of the biological effects of very low level of radiation will develop into a permanent branch of radiobiology while all the current assumptions and deductions, intuitions and educated guesses, fears and emotions on fallout danger will be no more convincing than the diminishing jaw.